A GUIDE TO THE NEW ZEALAND GRASS GENERA

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ABSTRACT

A key and checklist to the native and introduced genera of grasses occurring in New Zealand is given. There is a basic list of the recent literature on the taxonomy of native grasses and the characteristics of grasses are outlined.

INTRODUCTION

A comprehensive flora of the grasses (Poaceae) of New Zealand has never been published. The most recent treatments are of the indigenous grasses by Cheeseman (1925) and the adventive grasses by Allan (1940). However, a number of papers have appeared dealing with parts of the family, the most important being the article by Zotov (1963) on the Arundinoideae. There are a number of papers which consider individual genera or species, for example, Allan and Jansen 1939, Connor 1954, 1971, Zotov 1970, 1971a, 1971b, 1973. Zotov (1965) provided a comprehensive description of the grass flora of the Sub-Antarctic Islands and also made a number of important name changes (Zotov 1943). Recently, Lambrechsten (1972) produced a book which deals mostly with the adventive grasses of economic importance and concentrates on vegetative rather than reproductive characters.

Pending the production of a comprehensive flora, this article seeks to partially fill the vacuum by providing a key to the grass genera which are native or which have well-established adventive species in this country.

THE CHARACTERISTICS OF GRASSES

The feature which most deters the layman from taking an interest in grasses is that, to the untutored eye, they look rather alike. However they do have well-defined characters which can be used to differentiate them. Many features of grasses, largely those of the reproductive organs, are peculiar to this family and consequently require a specialised vocabulary to describe them. Presumably it would be possible to provide a key to the grasses based on vegetative characters but the required information is not available; however see Gould 1968. Hence the following key is based largely on reproductive features. A hand lens will be useful in determining some characters.

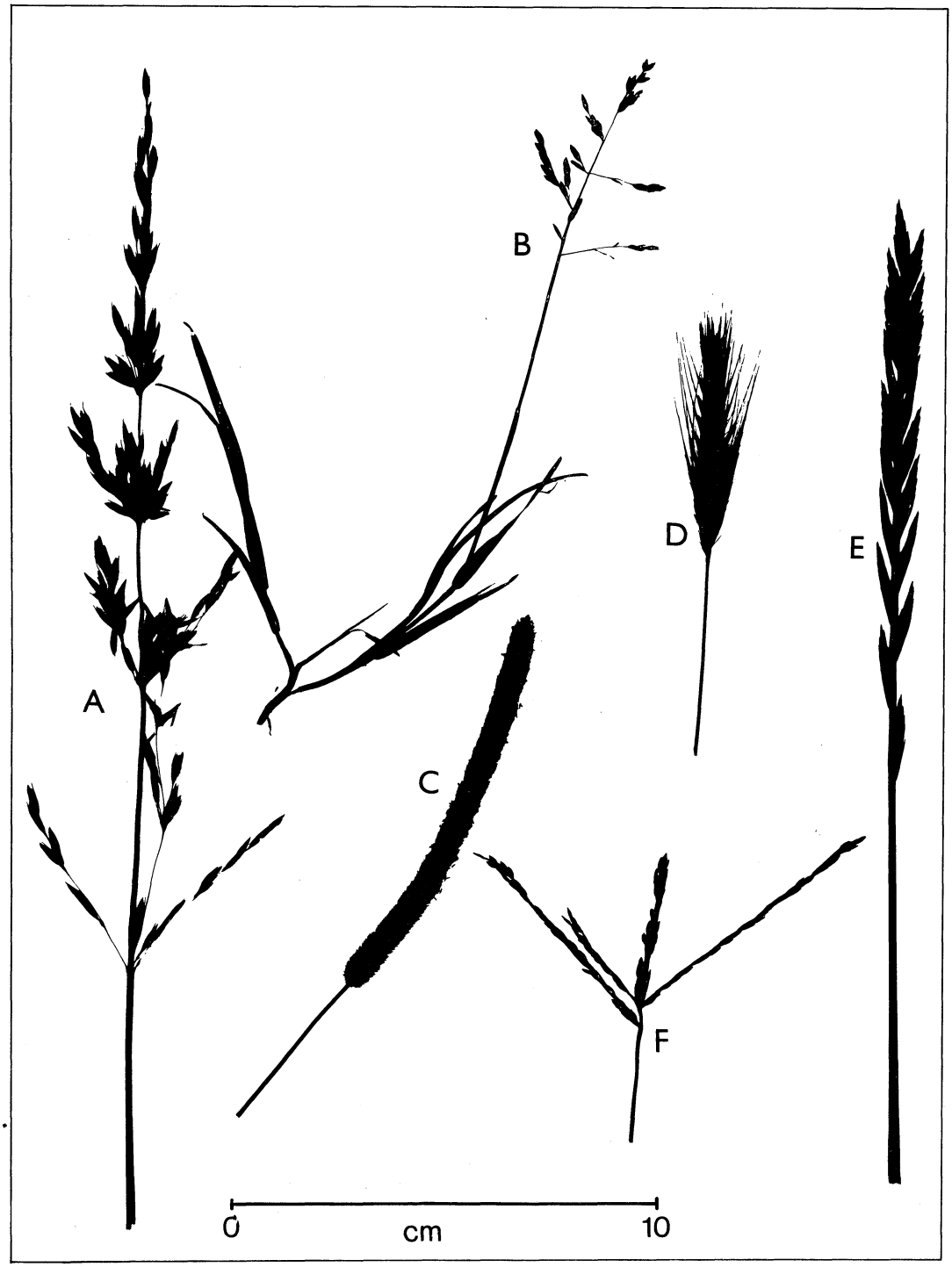

Fig. 1. Grass inflorescence types: A, B, open panicles (*Arrhenatherum, Poa*); C, condensed panicle forming cylindrical head (*Phleum*); D, E, spike (*Hordeum, Agropyron*); F, digitate cluster of spikes (*Digitaria*).

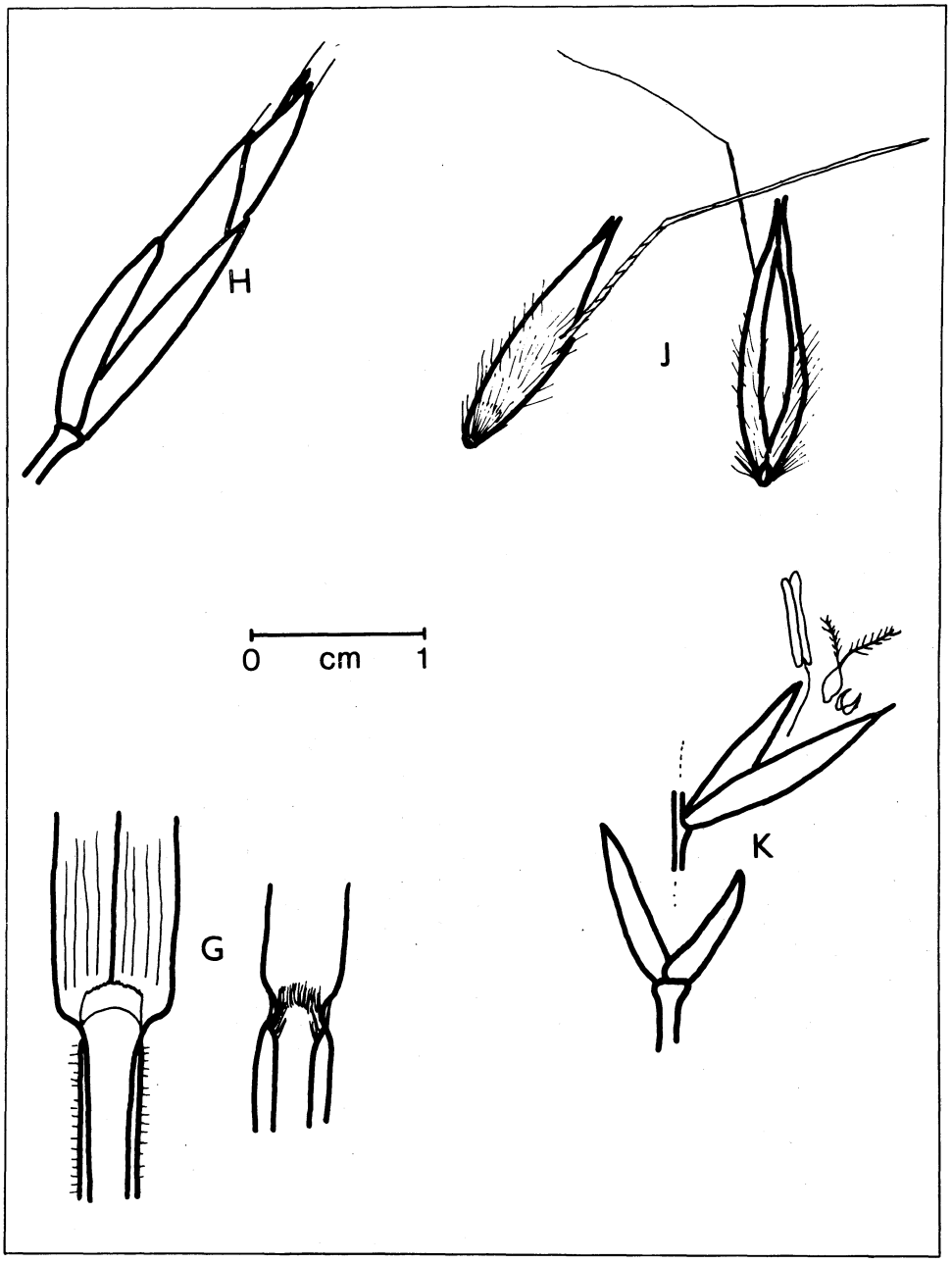

Fig. 2. G, types of ligules: membraneous (left) and hairy (right); H, spikelet of *Bromus* showing two glumes and three lemmar, the latter shortly awned from just below the apex; J, florets of *Avena* showing hairy lemma with long twisted awn from middle of back, which is inrolled and partially obscuring palea (right); K, diagram of expanded spikelet showing two basal glumes, central axis, lemma, palea, stamen, ovary with plumose stigmas and two minute lodicules.

Grasses usually have short-lived herbaceous stems, except in the bamboo where the stems are long-lived and become woody. The stems may be erect to prostrate and stoloniferous, or form underground rhizomes with scale leaves. Production of new stems occurs on lateral buds, in most species at ground level, where the new stems either arise within an old leaf sheath or break through the base of the sheath. Stems are circular in section or compressed. Aerial stems may have scale leaves at their bases and usually several to many leaves are produced above.

With rare exceptions, leaves in grasses are two-ranked although this feature is frequently not obvious. It is best observed in non-flowering shoots. The leaves consist of a sheath, which protects the younger parts of the stem and growing points, and a blade with an abrupt transition between the two. At their junction a small structure called a ligule occurs (Fig. 2G). The ligule is most commonly a membraneous tissue but it is also frequently a fringe of hairs. Rarely, the ligule is entirely absent, for example, *Echinochloa crus-galli*. The blade may be flat, folded or inrolled and is sometimes fine and bristle-like (setaceous).

The inflorescence consists of one to many spikelets which are arranged in panicles, spikes or racemes. The panicles are sometimes condensed with very short branchlets to produce a head or spike-like structure. The spikelets consist of several scale-like structures enclosing the floral organs. The lowermost structures on the spikelet are the glumes. These are empty, scale-like structures of which there are normally two though in some genera one or rarely both may be absent. Above these occur one to many florets. Each floret consists of two scales: the outer and more conspicuous one is known as the lemma, and the inner, which is thin and membraneous, is the palea. Within these occur the floral organs: three anthers and an ovary bearing two plumose stigmas. Two minute scale-like structures occur within the florets of many species. These are the lodicules and, when the conditions are satisfactory, these swell forcing the lemma and palea apart, thereby opening the floret. After fertilisation the ovary swells to form the grain. The lemmas and, less frequently, the glumes may possess awns which may be twisted and bent. These probably assist in photosynthesis, seed dispersal (e.g. catch in the fur of animals) and seed burial (effected by twisting and untwisting of the awn due to changes in atmospheric humidity).

In some genera one or more of the florets in a spikelet may be sterile or male and therefore not set seed. Occasionally some spikelets will be entirely sterile and usually structurally different from those fertile. In some species spikelets may be unisexual with male and female spikelets in different parts of the panicle, for example *Zizania*, in different inflorescences on the same plant, for example maize, (*Zea*), or on different plants, for example *Spinifex*.

This account is only a brief description of the grass plant. For a fuller description, as well as many detailed descriptions of species which have been introduced into New Zealand, see Hubbard (1968) or Gould (1968). The following key covers 74 genera which it might reasonably be claimed are

established in New Zealand. It includes oats (*Avena*) and barley (*Hordeum*) which have adventive species here but not wheat (*Triticum*) or maize (*Zea*) which are commonly cultivated.

KEY

1. Ligule a fringe of hairs or rarely entirely absent 2

   Ligule a membrane, often becoming torn with age and sometimes with lateral tufts of hairs 22

2. Rhizomatous grey-hairy dune grass; male plants with umbellate inflorescence; female with a globose, spiny head ..... *Spinifex*

   Not as above 3

3. Branchlets of inflorescence bearing bristles, or spikelets with an involucre of bristles or spines (lowland) 4

   Not as above 6

4. Branchlets of condensed panicle bearing 1-4 bristles which do not fall with the spikelet ..... *Setaria*

   Spikelets with involucres which fall with the mature spikelets 5

5. Inflorescence a condensed panicle; involucre of bristles ..... *Pennisetum*

   Inflorescence a spike; involucre of spines (Kermadec Is.) ..... *Cenchrus*

6. Inflorescence of one to several spikes, or condensed panicle resembling a spike; spikelets numerous (lowland) 7

   Inflorescence an open panicle or spikelets fewer than 12 13

7. Inflorescence a long, narrow, symmetrical, condensed panicle; spikelets small, terete ..... *Sporobolus*

   Inflorescence of distinctly one-sided spike(s); spikelets usually strongly compressed 8

8. Plant with long, stout, whitish stolons; leaves short and broad; spike usually solitary, strongly flattened ..... *Stenotaphrum*

   Not as above; inflorescence of 2 or more spikes 9

9. Robust salt-marsh plants forming large colonies; spikelets >10 mm long ..... *Spartina*

   Not as above; spikelets smaller 10

10. Spikelets of 3 or more fertile florets ..... *Eleusine*

    Spikelets of one fertile floret 11

11. Spikelets with a glume and a sterile floret enclosing the fertile floret ..... *Axonopus*

    Spikelets with two glumes, one or both shorter than the fertile floret 12

12. Tufted annuals; spikes pinnately arranged; lower glume short and clasping ..... *Echinochloa*

Rhizomatous perennial; spikes digitately arranged; both glumes short, not clasping ..... *Cynodon*

13. Lemmas awnless, ± hairless 14

Lemmas awned, noticeably hairy 20

14. Plants tufted; leaf blades 5-25 cm long (lowland) 15

Plants creeping or turf forming, small; blades usually <5 cm long 18

15. Glumes enclosing lemmas; spikelets 4-6 ..... *Sieglingia*

Glumes not enclosing lemmas; spikelets many 16

16. Spikelets with many fertile florets ..... *Eragrostis*

Spikelets with 2 florets, the lower sterile or male 17

17. Upper and lower lemmas similar, both hardened with inrolled margins (damp places) ..... *Isachne*

Upper lemma hardened and inrolled, lower resembling upper glume (waste places) ..... *Panicum*

18. Far creeping grass of lowland, open sandy places; spikelets with one floret ..... *Zoysia*

Turf-forming grasses of eastern dry, montane grasslands 19

19. Plants rhizomatous; spikelets 1-2 ..... *Pyrrhanthera*

Plants tufted; spikelets several ..... *Erythranthera*

20. Leaves not thickened; flat to bristle-like ..... *Notodanthonia*

Plants coarse, often robust, leaves thick, flat to rush-like 21

21. Leaves with several white lateral ribs in addition to midrib (except in cultivated species); lemmas 3-nerved ..... *Cortaderia*

Leaves without conspicuous lateral ribs; lemmas 7-9 nerved ..... *Chionochloa*

22. Inforescence with spikelets of two types: fertile spikelets usually awned, sterile or male spikelets usually awnless 23

Spikelets all similar and fertile 27

23. Inflorescence of digitately arranged spikes (lowland) ..... *Dichanthium*

Inflorescence otherwise 24

24. Panicle condensed, one-sided, spikelets with several florets, the fertile spikelets hidden by the sterile ..... *Cynosurus*

Panicle usually open, spikelets with one floret 25

25. Robust, rhizomatous grass of lowland river banks, upper panicle branches with female spikelets, lower with male ..... *Zizania*

Spikelets in clusters of 2 or more, one female, the others male or sterile (lowland) 26

26. Plants rhizomatous, spikelets in clusters of 2-3 ..... *Sorghum*

Plants tufted; clusters of 4 empty glumes surrounding 3 spikelets, the central fertile ..... *Themeda*

27. Inforescence of one to several spikes, if spikelets fewer than ten then large and more than 10 mm long 28

Inflorescence an open or condensed panicle; rarely spikelets solitary or few in a spike and then less than 5 mm long 40

28. Long, sprawling grass of lowland forests with spikelets in distant clusters ..... *Oplismenus*

Spikelets not in distant clusters 29

29. Spikes solitary; spikelets symmetrically arranged, few to many 30

Spikes 1-20, one-sided; spikelets numerous 36

30. Spikelets in clusters of 2-3 at each node 31

Spikelets solitary at each node 32

31. Spikelets in 3s, only the central of each cluster fertile, of one floret, long-awned ..... *Hordeum*

Spikelets of several florets, all fertile, short-awned; tall dune grasses ..... *Elymus*

32. Annual plants often with curved spikes, spikelets of one floret (coastal) ..... *Parapholis*

Spikelets of several florets 33

33. Spikelets edge on to stem; glume solitary except on terminal spikelet ..... *Lolium*

Spikelets terete or broadside on to stem; glumes 2 or 0 34

34. Glumes absent or less than half length of lemmas ..... *Cockaynea*

Glumes conspicuous, almost equalling lemmas 35

35. Spikelets ± compressed ..... *Agropyron*

Spikelets terete ..... *Brachypodium*

36. Leaves bristle-like; spike solitary, slender ..... *Nardus*

Leaves flat or folded; spikes rarely solitary (lowland) 37

37. Spikelets with 3 or more florets ..... *Eleusine*

Spikelets with 1-2 florets 38

38. Spikelets borne singly and widely spaced in 2 rows .... *Axonopus*

Spikelets usually paired and in 2-4 rows 39

39. Axis of spike flattened, 2-angled ..... *Paspalum*

Axis of spike 3-angled ..... *Digitaria*

40. Spikelets with one well-formed lemma, vestiges of others sometimes present (rarely a well-formed sterile lemma present in plants with conspicuous winged keels on glumes) 41

Spikelets with 2 or more well-formed lemmas, which may be fertile or sterile 57

41. Lemma conspicuously awned from apex 42

Lemma awnless or awned from back, rarely with a small weak awn from apex 45

42. Awn <7 mm long ..... *Oryzopsis*

Awn >10 mm long 43

43. Leaves flat or folded; panicle ± narrow, ± condensed ..... *Dichelachne*

Leaves bristle-like; panicle spreading or narrow 44

44. Lemma 1-2 mm long (excluding awn) ..... *Nassella*

Lemma >3 mm long (excluding awn) ..... *Stipa*

45. Spikelets in pairs which are hidden by an involucre of long silky hairs (lowland) ..... *Imperata*

Spikelets not paired, not hidden by silky hairs 46

46. Glumes distinctly awned or with rigid, diverging points; panicle dense 47

Glumes acute or obtuse but not awned or with rigid points; panicle open or dense 49

47. Glumes with rigid, diverging points; panicle cylindrical, <10 mm wide (grassland) ..... *Phleum*

Glumes awned; panicle 10-35 mm wide (lowland sandy places) 48

48. Plant softly hairy; glumes with hairy awns; lemma long-awned ..... *Lagurus*

Plant ± hairless; glumes with hairless, rough awns; lemma awnless or weakly awned ..... *Polypogon*

49. Weak, slender grasses; glumes minute, smaller than lemmas (rare) ..... *Simplicia*

Glumes >lemmas 50

50. Panicle a condensed head, spikelets many 51

Panicle open; spikelets many, few or solitary 54

51. Robust, rhizomatous, dune grass; spikelets >10 mm long, awnless ..... *Ammophila*

Spikelets <8 mm long (excluding awns) 52

52. Glumes white, with distinct green, winged keels; lemma awnless ..... *Phalaris*

Glumes otherwise; lemma usually awned 53

53. Panicle ovoid; awns rigid, rough (lowland forests)... *Echinopogon*

Panicle cylindrical; awns weak (grassland, swamps)... *Alopecurus*

54. Glumes swollen below due to small, hard floret (lowland) ..... *Gastridium*

Glumes not swollen below 55

55. Panicle spreading, delicate, brittle; lemma hairy ..... *Lachnagrostis*

Panicle not usually brittle; lemma hairless except for tuft at base 56

56. Spikelet axis silky; lemma with tuft of hairs at base ..... *Deyeuxia*

Spikelet axis rudimentary; lemma hairless ..... *Agrostis*

57. Spikelets with one perfect floret and one or two sterile or male florets 58

Spikelets with two or more perfect florets 62

58. Florets 2, lower perfect; plants softly hairy ..... *Holcus*

Uppermost floret perfect 59

59. Glumes small, less than lemmas ..... *Microlaena*

At least upper glume = or > lemma 60

60. Panicle condensed ..... *Anthoxanthum*

Panicle open 61

61. Spikelets broad, shiny; florets 3, awnless or with a short, straight awn ..... *Hierochloe*

Spikelets not shiny; florets 2, the lower with a long, twisted awn ..... *Arrhenatherum*

62. Lemma with awn, usually twisted, arising from middle of back or from the base 63

Lemma awnless or with a straight awn arising near the apex 67

63. Spikelets > 8 mm long (excluding awns) 64

Spikelets < 5 mm long (excluding awns) 65

64. Annual; upper glume >20 mm; spikelets drooping *Avena*

Semi-aquatic perennial; upper glume <15 mm; spikelets erect ..... *Amphibromus*

65. Annuals; leaves fine, ± dead at flowering; non-flowering stems absent, spikelets 2.5-3.5 mm long (dry places) ..... *Aira*

Perennials; green leaves and non-flowering stems present (grassland, swamps) 66

66. Lemma with two bristle points at apex; awn arising about middle of back ..... *Trisetum*

Lemma apex shortly toothed or torn, blunt; awn arising near base ..... *Deschampsia*

67. Lemmas keeled, laterally compressed, not rounded on back; spikelets <10 mm long, flattened 68

Lemmas rounded on back especially in lower part, sometimes keeled above, or if completely keeled then spikelets >12 mm long 70

68. Spikelets solitary to many, in an open panicle, awnless ..... *Poa*

Spikelets many, densely clustered, shortly awned 69

69. Panicle narrow, erect; spikelets shiny ..... *Koeleria*

Panicle one-side, spikelets in clusters at ends of close-set branches ..... *Dactylis*

70. Lemmas with rounded and blunt, occasionally bluntly toothed, apeces which are often whitish or translucent on the margin 71

Lemmas acutely pointed 75

71. Small annual with very rigid, one-sided panicles (dry, sandy places) ..... *Catapodium*

Not as above 72

72. Spikelets broad, drooping and nodding, (dry, sandy places) ..... *Briza*

Spikelets erect or spreading 73

73. Spikelets small, <3.5 mm long; lemmas <2 mm long, shining (grassland and swamps) ..... *Deschampsia*

Spikelets and lemmas larger than above 74

74. Ligule 5-15 mm long; lemma strongly nerved (swampy places) ..... *Glyceria*

Ligule <1 mm long; lemma not strongly nerved (saline places) ..... *Puccinellia*

75. Leaves ± flat, rolled when emerging; awn of lemma arising from small notch at apex or slightly below apex; or plant rhizomatous ..... *Bromus*

Plant tufted; leaves bristle-like or folded when emerging; awn, if present, apical 76

76. Perennials; lemmas pointed or with slender awns ..... *Festuca*

Annuals; spikelets erect; lemmas with long, rough awns (dry places) ..... *Vulpia*

SYNOPSIS OF THE GRASS GENERA IN NEW ZEALAND

This synopsis is based largely on that of Gould (1968) and reference should be made to this work for descriptions of the subfamilies and tribes. The approximate number of indigenous species (outside brackets) and adventive species (within brackets), excluding casuals, is indicated for each genus.

Festucoideae

Festuceae

Bromus (7), *Brachypodium* (1), *Briza* (2), *Catapodium* (1), *Cynosurus* (2), *Dactylis* (1), *Festuca* 5 (4), *Lolium* (3),

Poa 20 + (8), *Puccinellia* 6 (2), *Vulpia* (3).

Aveneae

Aira (3), *Agrostis* 11 (3), *Alopecurus* (3), *Ammophila* (1), *Amphibromus* 1, *Anthoxanthum* (2), *Arrhenatherum* (1), *Avena* (2), *Deschampsia* 6 (1), *Deyeuxia* 6, *Dichelachne* 2, *Echinopogon* 1, *Gastridium* (1), *Hierochloe* 7, *Holcus* (2), *Koeleria* 2, *Lachnagrostis* 10, *Lagurus* (1), *Microlaena* 6, *Phalaris* (4), *Phleum* (1), *Polypogon* (2), *Simplicia* 2, *Trisetum* 3.

Triticeae

Agropyron 4 (2), *Cockaynea* 2, *Elymus* (2), *Hordeum* (4), *Triticum* (1).

Meliceae

Glyceria (4).

Stipeae

Nassella (1), *Oryzopsis* 1 (1), *Stipa* 3 (1).

Monermeae

Parapholis (2).

Nardeae

Nardus (1).

Eragrostoideae

Eragrosteae

Eragrostis (1), *Sporobolus* (1).

Chlorideae

Cynodon (1), *Eleusine* (1), *Spartina* (2).

Zoysieae

Zoysia 3.

Oryzoideae

Oryzeae

Zizania (1).

Arundinoideae

Cortaderieae

Cortaderia 4 (1).

Danthonieae

Chionochloa 20, *Erythranthera* 2, *Notodanthonia* 11 (11), *Pyrrhanthera* 1, *Sieglingia* (1).

Panicoideae

Paniceae

Axonopus (2), *Cenchrus* 1, *Digitaria* (2), *Echinochloa* (2), *Isachne* 1, *Oplismenus* 1, *Panicum* (2), *Paspalum* (5), *Pennisetum* (4), *Setaria* (4), *Spinifex* 1, *Stenotaphrum* (1).

Andropogoneae

Dichanthium (1), *Imperata* 2, *Sorghum* (1), *Themeda* (1), *Zea* (1).

Bambusoideae (not included in this work)

GLOSSARY

The meaning of the following terms may not be readily apparent from the general description or the illustration:

DIGITATE:	Arranged like the fingers of the hand.
INVOLUCRE:	A number of bracts, bristles or spines surrounding a spikelet or cluster of spikelets.
KEEL:	Projecting ridge on a flat or convex surface, as the keel of a boat.
RHIZOME:	Underground stem lacking chlorophyll and with scale leaves, by which the plant spreads.
STOLON:	Above ground creeping and rooting stem, by which the plant spreads.
TERETE:	Cylindrical, circular in section, not ridged or flattened.
UMBELLATE:	Arranged like the spokes of an umbrella.

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